

# Nuclear Instruments and Methods

João B. Manteigas

The strategy of the group involves activities in the following lines:

1. Modelling of radiation fields, calculation of neutron physics parameters, measurement of neutron cross-sections;
2. Modelling of gas discharges;
3. Development of software for control;
4. Design of electronic instrumentation for nuclear applications;
5. Instrumentation and technical assistance.

## *Modelling of radiation fields, calculation of neutron physic parameters*

Monte Carlo calculations have been carried out in the framework of the EUROTRANS Project (IP EUROTRANS, 516520), the CANDIDE Project (Coordination Action on Nuclear Data for Industrial Development in Europe, 036397), and the n\_TOF Collaboration (ITN participation in the n\_TOF-phase 2 experiment at CERN).

## *Measurement of neutron cross-sections*

The analysis of the data for cross-section measurement, taken in the TOF spectrometer installed at CERN, was carried out.

## *Modelling of gas discharges*

1. The PLASMAKIN chemical kinetics software package was updated: The libpk library was extended to provide access from C programs and a Python extension module was developed to provide access to libpk from Python programs.
2. The study of the electron kinetics in Ar-X [ $< 2\%$ ] (where X is H<sub>2</sub>, N<sub>2</sub>, O<sub>2</sub> or H<sub>2</sub>O) mixtures with application on GDS (Glow Discharge Optical Emission

Spectroscopy) has continued with the characterization of Ar and Ar-H<sub>2</sub> mixtures.

## *Design of electronic instrumentation*

- One “Radioscan” Gamma Isotope TLC Analyser for measuring and recording radioactivity levels, on labels or strips, to be used in TLC and HPLC at ITN/DPRSN;
- Three “6 Channel Micro-Current Source”, multiple precision current source, used in electrochemical, electromagnetic and electronic experiments, at ITN/Química.

## *Instrumentation and Technical Assistance*

The main objectives are the development of equipment for internal groups, fabrication of equipment for specific applications and assistance to industrial companies and scientific institutions as well as technical consulting.

The technical assistance takes mainly the forms of specialised consultant engineering advice, installation of nuclear gauges, including calibration maintenance and repair and recharging of gauges with imported radioactive sources.

## *Co-operation with other institutions*

The Group is involved in the following collaborations:

1. n\_TOF collaboration, a consortium of 40 laboratories in Europe and USA;
2. Plasma Physics Center/Gas Electronics Group, IST;
3. Research Institute for Solid State Physics and Optics, Budapest, Hungary.

## **Researchers**

J. MANTEIGAS, Aux., Group Leader  
C. CRUZ, Aux.  
I.F. GONÇALVES, Aux.  
J. NEVES, Aux.  
N. PINHÃO, Aux. (40%)

## **Students**

C.M. CARRAPIÇO, Ph.D. Student, IST  
C. SANTOS, M.Sc. Student, FC-UL

## **Technical Personnel**

T. JESUS, Electronics Technician  
N. INÁCIO, Electronics Technician  
M. CABAÇA, Mechanical Technician

# Technical Assistance in the Field of Engineering Applications of Radiation and Radioisotopes

J.B. Manteigas, J. Neves, C. Cruz

## Objectives

The main objectives are the development of equipment for internal groups, fabrication of equipment for specific applications and assistance to industrial companies and scientific institutions as well as technical consulting.

## Results

A summary of the more relevant work carried out is:

- (i) Collaboration in the installation of the “Ion Beam Laboratory – TANDEM 3 MV” at the Physics Sector.
- (ii) Collaboration on the acquisition, construction and installation of the LCEA (Characterisation and

Speciation of aerosols Laboratory Project (REEQ/ /377/FIS/2005).

- (iii) Collaboration on the upgrading of the Radiation Technology Unit (UTR) (Project REEQ/996/BIO/ /2005).

- (iv) Technical support (development of electronic circuits) to be used in “Perturbed Angular Correlations experiments” at the RPI (Project POCTI/FIS/ /58498/2004).

- (v) Development and maintenance of electronic equipment to RPI, Physics, Chemical, UTR and DPRSN Sectors.



## Summary of the more relevant Services/Equipments rendered in 2007

Activity	Qty	Client
Laboratory equipment for the determination of radioactive element traces by electrodeposition	1	UNIWERSYTET GDANSKI (Poland)
	1	HASSAN GHEETH (Germany)
	1	THAILAND INSTITUTE OF NUCLEAR TECHNOLOGY (Thailand)
	1	AIEA (Sri Lanka)
- Electrodeposition cells	1	CENTRE NATIONAL DES SCIENCES ET TECNOLOGIES NUCLEARES (Tunisia)
Personal Radiation Dosemeter Equipment	1	SOPORCEL
- Technical assistance	4	DIRECÇÃO GERAL DE NAVIOS BASE N. DE LISB. ALFEITE
	4	DIRECÇÃO GERAL DE NAVIOS BASE N. DE LISB. ALFEITE
	1	DIRECÇÃO GERAL DE NAVIOS BASE N. DE LISB. ALFEITE
	4	DIRECÇÃO GERAL DE NAVIOS BASE N. DE LISB. ALFEITE
	1	ITN/RPI
	1	ITN/RPI
	1	ORTOGNATICA
Technical assistance to - Source Containers	1	INSTITUTO SUPERIOR DE AGRONOMIA
	1	INSTITUTO SUPERIOR DE AGRONOMIA
	6	SN SEIXAL - SIDERURGIA NACIONAL SA
	1	SN SEIXAL - SIDERURGIA NACIONAL SA
Measuring and control of sources activities	5	EMA 21 - GRUPO PORTUCEL/SOPORCEL – FIGUEIRA DA FOZ
	20	EMA 21 - GRUPO PORTUCEL/SOPORCEL – FIGUEIRA DA FOZ
	19	EMA 21 - GRUPO PORTUCEL/SOPORCEL – CACIA
	6	EMA 21 - GRUPO PORTUCEL/SOPORCEL – FIGUEIRA DA FOZ
Prices including TAX (VAT)		<b>Total Amount: 18 593,81€</b>

**Participation of ITN in the n\_TOF phase 2 experiment**

*P. Vaz, I.F. Gonçalves, C. Cruz, J. Neves, C. Carrapiço, C. Santos, L. Ferreira, L. Távora<sup>1</sup>*

The n\_TOF phase2 project is the continuation of the involvement of ITN in the activities of the n\_TOF Collaboration. The intention of the n\_TOF Collaboration is to build a second n\_TOF beam-line and a new experimental area (EAR-2) using a shorter flight path (20 meters), with lower backgrounds and count rates in the detectors, making possible the extension of measurements to higher energies and the availability of a higher neutron flux (a factor of 100).

A team of researchers of ITN has been involved in Monte Carlo simulation activities, data analysis and development of electronics for the BaF2 calorimeter. ITN is strongly involved in collaboration with CIEMAT-Madrid, INFN-Bari and CEA, Saclay, in the following areas: Monte Carlo simulation(I) - full and detailed simulation of the geometry of the new experimental area, computation of the particle fluxes, assessment of the backgrounds, with the usage of the state-of-the-art Monte Carlo codes MCNPX and GEANT-4; Monte Carlo simulation studies (II) - continuation of the studies to simulate the response of the BaF2 calorimeter, calibration and efficiencies on a module-by-module basis; Data analysis (I) - continuation of the analysis of the following data sets: Au-197, Np-237, Pu-240, initiated during 2005, using the BaF2 calorimeter; Electronics developments for the DAQ and the BaF2 calorimeter.

---

<sup>1</sup> Centro de Instrumentação / U. Coimbra

---

**Development of an open source software package for plasma physics modelling**

*N. R. Pinhão*

The PLASMAKIN chemical kinetics package has been extended to support new reaction processes and expanded with new modules. Presently the package includes a chemical kinetics library, an electron kinetics library solving the electron Boltzmann equation in the classical two-term expansion and a Python extension module. Work is underway to extend the electron kinetics library to include a density gradient method and to include in the package a database for species and reaction. The project was moved to Source forge (<http://plasmakin.sourceforge.org>).

---

**Electron kinetics in gas mixtures used for Analytical Glow Discharge Optical Emission Spectroscopy**

*Z. Donkó, M. J. Pinheiro, N. R. Pinhão, P. Hartmann*

The electron energy distribution functions in pure argon and argon-H<sub>2</sub> mixtures have been studied. The numerical methods used include a two-term Boltzmann solver, a density-gradient expansion and a Monte-Carlo method. Two different sets of electron collision cross sections for hydrogen have been tested and the transport parameters obtained have been compared with experimental values